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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS AND INTERFERENCES

In re

INVENTOR:	Francisco Juarez	)	EXAMINER:	Michael G. Miller
		)		
SERIAL NO.:	10/821,092	)	ART UNIT:	1709
		)		
FILING DATE:	April 8, 2004	)	DATE:	February 25, 2009
		)		

FOR: METHOD AND APPARATUS FOR MODULATION OF PRECURSOR EXPOSURE DURING A PULSED DEPOSITION PROCESS

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BRIEF FOR APPELLANTS

This is an appeal from the final rejection by the Examiner mailed October 28, 2008, rejecting claims 1-10 and 20-28. A notice of appeal and the appeal fee were timely mailed on January 28, 2008. Credit card payment of $540 for the appeal brief fee (large entity) is enclosed. Please charge any over or under payment to the undersigned's Deposit Account No. 04-0566.

REAL PARTY IN INTEREST

The real party in interest is the assignee of all rights in this application, Novellus Systems, Inc., a corporation of the State of California, having a place of business at 4000 First Street, San Jose, California 95134.

RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to appellants, appellants' legal representatives or assignee, which will directly affect or be affected by, or have a bearing on the Board's decision on this appeal.

STATUS OF CLAIMS

The subject application was filed on April 8, 2004 with claims 1-19. An amendment was filed on August 27, 2007, responsive to the non-final office action mailed May 25, 2007, amending claims 1, 2, 6-8 and 10, and adding new claims 20-22. Appellants also cancelled claims 11-19, which were non-elected after a restriction requirement. A final office action was mailed November 16, 2007, and a response was filed on January 16, 2008 without claim amendment. An RCE was filed on February 13, 2008 along with an amendment amending claims 1-5, 8 and 9 and adding new claims 23-28.

A non-final Office action was mailed April 24, 2008 and a response thereto was filed July 24, 2008 without claim amendment. In an office action mailed October 28,

2008, a final rejection was made of all of the claims in the application, to wit, claims 1-10 and 20-28. Appellants are appealing the rejection of these claims.

STATUS OF AMENDMENTS

All the amendments made during prosecution of the application have been entered and are presently in the application. The rejected claims 1-10 and 20-28, as they presently stand, are set forth in the Appendix. A summary of the rejection of the claims may be found in the Office Action mailed October 28, 2008.

SUMMARY OF CLAIMED SUBJECT MATTER

As recited in independent claim 1, the invention is directed to a method of depositing material on a substrate which initially comprises providing a reactor 10 (Figs. 1 and 2, ¶ 0026) with a reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) having a first volume 103 (Fig. 1, ¶ 0028). The method then includes securing a substrate 105 (Fig. 1, ¶ 0027) within the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026). The method then includes introducing a first precursor 24 (Fig. 3, ¶ 0030) into the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) at the first chamber volume 103 (Fig. 1, ¶ 0028) and contacting a surface of the substrate 105 (Fig. 1, ¶ 0027) in the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) with the first precursor 24 (Fig. 3, ¶ 0030) at the first chamber volume 103 (Fig. 1, ¶ 0028) to cause a reaction (¶ 0030) of the first precursor 24 (Fig. 3, ¶ 0030) with and deposit a first layer on the substrate 105 (Fig. 1, ¶ 0027). The method then includes

enlarging the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) to a second, larger volume 103, 104 (Fig. 2, ¶ 0028) to reduce concentration of the first precursor and removing undeposited first precursor 26 (Fig. 3, ¶ 0030) to end reaction of the first precursor.

Independent claim 8 is directed to a method of depositing a film on a substrate initially comprising providing a reactor 10 (Figs. 1 and 2, ¶ 0026) having a reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026), the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) including a pedestal 102 (Figs. 1 and 2, ¶ 0027) adapted to secure a substrate 105 (Fig. 1, ¶ 0027) during the deposition and movable within the chamber between an upper position and a lower position, the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) having a first volume 103 (Fig. 1, ¶ 0028) when the pedestal 102 (Figs. 1 and 2, ¶ 0027) is in the upper position 102 (Fig. 1, ¶ 0027) and a second, larger volume 103, 104 (Fig. 2, ¶ 0028) when the pedestal is in the lower position 102 (Fig. 2, ¶ 0027). The method then includes securing a substrate 105 (Fig. 1, ¶ 0027) on the pedestal 102 (Fig. 1, ¶ 0027). The method then includes introducing a first precursor 24 (Fig. 3, ¶ 0030) into the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) when the substrate 105 (Fig. 1, ¶ 0027) is on the pedestal 102 (Fig. 1, ¶ 0027) is in the upper position at the first chamber volume 103 (Fig. 1, ¶ 0028), and contacting a surface of the substrate 105 (Fig. 1, ¶ 0027) in the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) with the first precursor 24 (Fig. 3, ¶ 0030) at the first chamber volume 103 (Fig. 1, ¶ 0028) to cause a reaction (¶ 0030) of the first precursor 24 (Fig. 3, ¶ 0030) with and deposit a first layer on the substrate 105 (Fig. 1, ¶ 0027). The

method then includes lowering the pedestal 102 (Fig. 2, ¶ 0027) to the lower position to enlarge the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) to the second, larger volume 103, 104 (Fig. 2, ¶ 0028) to reduce concentration of the first precursor and removing undeposited first precursor 26 (Fig. 3, ¶ 0030) to end reaction of the first precursor. The method then includes raising the pedestal 102 (Fig. 1, ¶ 0027) to the upper position to reduce the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) to the first chamber volume 103 (Fig. 1, ¶ 0028), and introducing a second precursor 28 (Fig. 3, ¶ 0030) into the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) when the substrate 105 (Fig. 1, ¶ 0027) is on the pedestal 102 (Fig. 1, ¶ 0027) is in the upper position at the first chamber volume 103 (Fig. 1, ¶ 0028), and contacting the first layer in the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) with the second precursor 28 (Fig. 3, ¶ 0030) at the first chamber volume 103 (Fig. 1, ¶ 0028) to cause a reaction (¶ 0030) of the second precursor 28 (Fig. 3, ¶ 0030) with and deposit a second layer on the first layer, thereby forming a film. The method then includes lowering the pedestal 102 (Fig. 2, ¶ 0027) to the lower position to enlarge the reaction chamber 103, 104 (Figs. 1 and 2, ¶ 0026) to the second volume 103, 104 (Fig. 2, ¶ 0028) to reduce concentration of the second precursor 30 (Fig. 3, ¶ 0030) and removing undeposited second precursor to end reaction of the second precursor.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The contested issue in this appeal is whether claims 1-10 and 20-28 are obvious to one of ordinary skill in the art under 35 USC § 103 from Santiago U.S. Patent No. 6,716,287 ("Santiago '287") in view of Luo et al. U.S. Patent Publication No. 2003/0059535 ("Luo '535").

ARGUMENT

I. The cited art

A. Santiago '287

Santiago '287 discloses a processing chamber useful for chemical vapor deposition (CVD). CVD is generally employed to deposit a thin film on a substrate or semiconductor wafer and is generally accomplished by introducing a precursor gas into a vacuum chamber. The precursor gas is typically directed through a showerhead or other inlet situated near the top of the chamber. The precursor gas reacts to form a layer of material on the surface of the substrate that is positioned on a heated substrate support. Column 1, lines 38-44. The CVD chamber includes support assembly that is disposed beneath the showerhead, and which supports a substrate during processing. The support assembly is further described as follows in one of the portions of Santiago '287 cited by the Examiner:

> The support assembly 138 is coupled to a lift mechanism 144 by a shaft 126. The lift mechanism 144 enables the support assembly 138 to be moved between an upper position proximate the showerhead 118 as shown in FIG. 1 and a lower position that facilitates substrate transfer between the support assembly 138 and a robot (not shown). Bellows 146 provide a vacuum seal

> between the process volume 112 and the atmosphere outside the chamber 100 while facilitating the movement of the support assembly 138.

Column 3, lines 53-65. The CVD process is only vaguely described, with emphasis on improving gas flow within the chamber. All of the drawing figures show the chamber in the upper, raised position proximate the showerhead, and Santiago '287 discloses no process in which a precursor remains in the reaction chamber as the support assembly is lowered, either to reduce concentration thereof or otherwise to end the reaction of the precursor.

B. Luo '535

The Luo '535 reference discloses the cyclic deposition of films in a process chamber. In a passage cited by the Examiner, one embodiment of the process is described:

> This method of one embodiment for SiN deposition is accomplished with an alternating flow of the two reactive gasses under careful process controls. The flow of ammonia can first be applied onto the wafer surface and then stopped, where the wafer surface can be pre-heated to approximately 500°C. Residual ammonia and N-containing reactive species in the process chamber can be removed by pump and purge. A flow of HCD can then be applied to the wafer still heated to approximately 500°C. and the flow then stopped. The flow of HCD and ammonia reactive gasses can be continued to alternately apply each half layer until a final film thickness is achieved. Each flow step can be followed by a pump only, a purge only or a pump step coupled with a purge with the wafer temperature maintained at approximately 500°C. throughout the process.

Paragraph 0036. Luo '535 does not describe any change in chamber volume, nor any mechanism for changing the chamber volume, during either the deposition process or even afterwards during the pump or purge stage.

II. Claims 1, 3-7, 20, 23 and 25

Applicants' invention as described in claims 1 and 3-7 recite that, at the first chamber volume, there is a reaction of the precursor with the substrate to deposit the layer and that the reaction chamber is subsequently enlarged to a second, larger chamber volume to reduce the concentration of the precursor and remove undeposited precursor to end reaction of the precursor.

The Santiago '287 patent discloses no process in which a precursor remains in the reaction chamber as the support assembly is lowered. Santiago '287 suggests only that the support assembly is lowered for the purpose of "transfer between the support assembly 138 and a robot" and not during the deposition processing itself. Accordingly, there is no disclosure or suggestion of appellant's method of enlarging the reaction chamber to a second, larger volume to reduce concentration of the first precursor and removing undeposited first precursor to end reaction of the first precursor.

Luo '535 does not make up for the deficiencies of Santiago '287 and does not describe any change in chamber volume, nor any mechanism for changing the chamber volume, during either the deposition process or even afterwards during the pump or purge stage. Luo '535 shows no recognition of appellants' improved deposition process that uses a variable chamber volume while the precursor is still in contact with the substrate to reduce concentration and end the reaction.

Since neither Santiago '287 nor Luo '535 describe a reaction with a precursor to deposit a layer that takes place during enlargement of a reaction chamber from the a

chamber volume to a second, larger chamber volume, the present invention is not *prima facie* obvious from a combination of these references. Both references lack any teaching or suggestion of reducing concentration of a precursor and removing undeposited first precursor to end reaction thereof by enlarging the reaction chamber from a first volume to a second, larger volume. The Examiner's reference to the ideal gas law is irrelevant, since neither reference teaches leaving the precursor in the reaction chamber while it is enlarged. The only suggestion of doing so is from appellants' own specification, which therefore represents impermissible hindsight analysis.

III. Claims 2, 8-10, 21, 22, 24 and 26

Applicants' invention as described in claims 2 and 8 include the method of claim 1, and further recite a second precursor reaction in which the second precursor contacts the first deposited layer at the first chamber volume and the reaction chamber is subsequently enlarged to the second, larger chamber volume to reduce the concentration of the second precursor and remove undeposited precursor to end reaction of the second precursor. Neither Santiago '287 nor Luo '535 disclose or suggest such second precursor reaction and chamber enlargement to end the second precursor reaction, for the reasons given above.

IV. Claims 27 and 28

Claims 27 and 28 recite that the pedestal 102 (Fig. 4) has a diameter greater than the spacing between the first chamber section side walls 117 (Fig. 4, ¶ 0034), and wherein the pedestal has chamfered edges 116 (Fig. 4, ¶ 0034) that correspond with the chamfered

corners 118 (Fig. 4, ¶ 0034) on the lower ends of the first chamber section side wall 117 (Fig. 4, ¶ 0034).

The Examiner has cited Santiago '287 for such teaching, specifically, at column 4, lines 21-29 and Figs. 1 and 2. Contrary to the Examiner's position, the Santiago '287 support assembly 138 is of smaller diameter than the flange 114 that forms the upper part of the sidewalls 106. Likewise, there are no chamfered edges that correspond with chamfered corners in Santiago '287. Accordingly, the combination of Santiago '287 and Luo '535 does not disclose or suggest the subject matter of claims 27 and 28.

CONCLUSION

For the reasons given above, appellants submit that the claims of the instant application are not obvious from the cited prior art. Reversal of the rejection under 35 USC § 103 is respectfully requested.

Respectfully submitted,

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CLAIMS APPENDIX

Rejected Claims of U.S. Serial No. 10/821,092

1. (previously presented) A method of depositing material on a substrate comprising:

providing a reactor with a reaction chamber having a first volume;

securing a substrate within the reaction chamber;

introducing a first precursor into the reaction chamber at the first chamber volume;

contacting a surface of the substrate in the reaction chamber with the first precursor at the first chamber volume to cause a reaction of the first precursor with and deposit a first layer on the substrate; and

enlarging the reaction chamber to a second, larger volume to reduce concentration of the first precursor and removing undeposited first precursor to end reaction of the first precursor.

2. (previously presented) The method of claim 1 further including:

reducing the reaction chamber to the first chamber volume;

introducing a second precursor into the reaction chamber at the first chamber volume;

contacting the first layer in the reaction chamber with the second precursor at the first chamber volume to cause a reaction of the second precursor with and deposit a second layer on the first layer, thereby forming a film; and

enlarging the reaction chamber to the second volume to reduce concentration of the second precursor and removing undeposited second precursor to end reaction of the second precursor.

3. (previously presented) The method of claim 1 wherein removing undeposited first precursor is by purging the reaction chamber at the second volume with a gas.

4. (previously presented) The method of claim 1 wherein removing undeposited first precursor is by exposing the reaction chamber at the second volume to a vacuum.

5. (previously presented) The method of claim 1 wherein the reaction chamber includes a pedestal adapted to secure the substrate during the deposition and movable within the chamber betweens an upper position and a lower position, the reaction chamber having the first volume when the pedestal is in the upper position and the second, larger volume when the pedestal is in the lower position, a first chamber section above the pedestal in the upper position defining the first chamber volume, and a second chamber section outside the first chamber section; and wherein the reaction chamber is enlarged to the second, larger volume by moving the pedestal to the lower position such that the first and second chamber sections together with the pedestal in the lower position define the second chamber volume.

6. (previously presented) The method of claim 1 wherein the second chamber volume is on one or more sides of the pedestal.

7. (previously presented) The method of claim 1 wherein the second chamber volume is below the pedestal.

8. (previously presented) A method of depositing a film on a substrate comprising:

providing a reactor with a reaction chamber, the reaction chamber including a pedestal adapted to secure a substrate during the deposition and movable within the chamber between an upper position and a lower position, the reaction chamber having a first volume when the pedestal is in the upper position and a second, larger volume when the pedestal is in the lower position;

securing a substrate on the pedestal;

introducing a first precursor into the reaction chamber when the substrate is on the pedestal is in the upper position at the first chamber volume;

contacting a surface of the substrate in the reaction chamber with the first precursor at the first chamber volume to cause a reaction of the first precursor with and deposit a first layer on the substrate;

lowering the pedestal to the lower position to enlarge the reaction chamber to the second, larger volume to reduce concentration of the first precursor and removing undeposited first precursor to end reaction of the first precursor;

raising the pedestal to the upper position to reduce the reaction chamber to the first chamber volume;

introducing a second precursor into the reaction chamber when the substrate is on the pedestal is in the upper position at the first chamber volume;

contacting the first layer in the reaction chamber with the second precursor at the first chamber volume to cause a reaction of the second precursor with and deposit a second layer on the first layer, thereby forming a film; and

lowering the pedestal to the lower position to enlarge the reaction chamber to the second volume to reduce concentration of the second precursor and removing undeposited second precursor to end reaction of the second precursor.

9. (previously presented) The method of claim 8 wherein the reaction chamber includes a first chamber section above the pedestal in the upper position defining the first chamber volume, and a second chamber section outside the first chamber section; and wherein the reaction chamber is enlarged to the second, larger volume by moving the pedestal to the lower position such that the first and second chamber sections together with the pedestal in the second position define the second chamber volume.

10. (previously presented) The method of claim 1 wherein the second chamber volume is on the side of and below the pedestal.

11-19. (cancelled)

20. (previously presented) The method of claim 1 further including providing a perforated plate above the pedestal in the reactor chamber, and diffusing the first precursor through the perforated plate into the reaction chamber.

21. (previously presented) The method of claim 2 further including providing a perforated plate above the pedestal in the reactor chamber, and diffusing the first and second precursors through the perforated plate into the reaction chamber.

22. (previously presented) The method of claim 8 further including providing a perforated plate above the pedestal in the reactor chamber, and diffusing the first and second precursors through the perforated plate into the reaction chamber.

23. (previously presented) The method of claim 1 wherein the first layer is a different composition than the first precursor.

24. (previously presented) The method of claim 2 wherein the second layer is a different composition than the second precursor.

25. (previously presented) The method of claim 5 wherein the first layer is a different composition than the first precursor.

26. (previously presented) The method of claim 8 wherein the first layer is a different composition than the first precursor, and the second layer is a different composition than the second precursor.

27. (previously presented) The method of claim 5 wherein the first chamber section above the pedestal has spaced side walls and chamfered corners on lower ends of the side walls, wherein the pedestal has a diameter greater than the spacing between the first chamber section side walls, and wherein the pedestal has chamfered edges that correspond with the chamfered corners on the lower ends of the first chamber section side walls.

28. (previously presented) The method of claim 9 wherein the first chamber section above the pedestal has spaced side walls and chamfered corners on lower ends of the side walls, wherein the pedestal has a diameter greater than the spacing between the first chamber section side walls, and wherein the pedestal has chamfered edges that

correspond with the chamfered corners on the lower ends of the first chamber section side walls.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None